A.4.1

Environmental and Safety Engineering Staff
Ford Motor Company

Suite 608
15201 Century Drive
Dearborn, Michigan 48120

August 4, 1993

Mr. Jim Sygo, Chief
Waste Management Division
Michigan Department of Natural Resources
P.O. Box 30028
Lansing, Michigan 48909

Subject: **Allen Park Clay Mine Landfill - Cell II Certification Documents**

Dear Mr. Sygo

Pursuant to 40 CFR §264.19(d) and our Act 64 Operating License, submitted herewith are two sets of the Golder Construction Services, Inc. document entitled "Report On Construction Quality Assurance Monitoring Services - Cell II" dated June, 1993. One additional set each is being forwarded to the U. S. Environmental Protection Agency and Dr. Benedict Okwumabua of the MDNR District Office in Livonia.

If you have any questions please contact Jeff Hartlund of this Office at (313)322-0700.

Sincerely,

Jerome S. Amber, P.E., Manager
Wastes and Hazardous Substances
Environmental Quality Office
313/322-0700

Enclosures

cc: Dr. Benedict Okwumabwa w/ enclosure
U.S. EPA Region 5 w/ enclosure
Mr. Pete Quackenbush w/out enclosure

DEPARTMENT OF NATURAL RESOURCES
HAZARDOUS WASTE DIVISION

STAFF REPORT

DAY: S | M | T | W | TH (X) | F | S

- ☐ Complaint Inspection
- ☐ Compliance Inspection
- ☒ Construction Inspection
- ☐ Permitting Inspection
- ☐ PEAS Investigation
- ☐ PCB Report/Complaint
- ☐ Sampling Inspection
- ☐ Telephone Call
- ☐ Meeting Notes
- ☐ Other _____

WEATHER	Brite Sun	Clear (X)	Overcast	Rain	Snow
TEMP	To 32	32-50	50-70	70-85 (X)	85 up
WIND	Still	Moder. (X)	High	Report No.	
HUMIDITY	Dry	Moder. (X)	Humid.		

- ☒ Act 64 _____
- ☐ Act 136 _____
- ☐ Act 245 _____
- ☐ RCRA _____

DATE: 7-10-86 TIME: 12:30

COMPANY/FACILITY: Ford - Allen Park Claymine Landfill

FACILITY NO.:

ADDRESS/LOCATION:

STAFF: McNiel, Romero

PARTICIPANTS: Dave Miller (Ford), Dan Booth (WDI)

Preliminary preparations for closure of Cell I have begun to include:

1. Grading of unfilled cell bottom in preparation of placing leachate collection system.
2. Exposed dikes around cell I and partial removal of eight berm along east edge of cell.

Landfill does not have approved closure plan at this time but is anticipating approval soon - Are therefore doing preliminary items so that completion of closure can be accomplished this construction season - Advised that any closure activities are at risk of non-approval.

Noted areas of concern:

a. Leachate level exceeded 6" (≈ 1-2') - Advised to pump down immediately
b. Leachate seeps (Act 641) noted in 2 areas shown on attached (Fig. 2) sheet - Advised that they be taken care of immediately
c. Track out from dozer in cell bottom & leachate problem - scraping of heavy stuff is method used before going to other parts of site (Northville) Decontamination needs to be upgraded

SIGNED

Distribution: Original - District/Lansing C&E File.
1st copy - Lansing _____ File/District
2nd copy - Inspector
[illegible] - US EPA

R-5114
Rev. 1/86

DEPARTMENT OF NATURAL RESOURCES
HAZARDOUS WASTE DIVISION

STAFF REPORT

DAY | S | M | T | W | TH | F | S |

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- ☐ Act 136 _____
- ☐ Act 245 _____
- ☐ RCRA _____

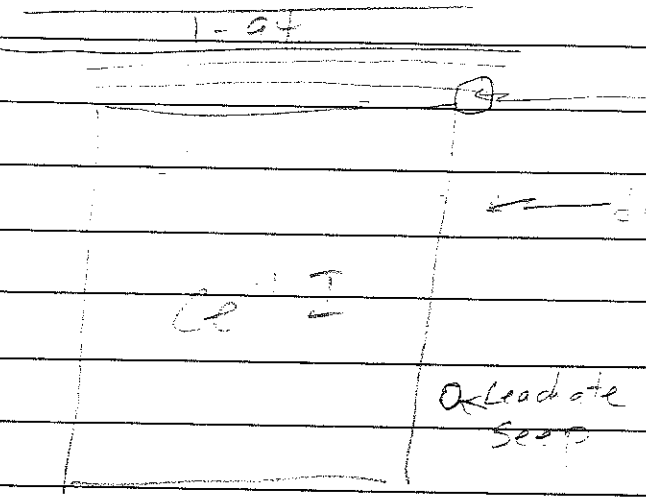
DATE: 7-10-86 | TIME:

COMPANY/FACILITY: Ford - Allen Park | FACILITY NO.:

ADDRESS/LOCATION: | STAFF:

PARTICIPANTS:

Called Northville district office & talked to Faye Dodd regarding above concerns



SIGNED

Distribution: Original - District/Lansing _____File.
1st copy - Lansing _____File/District
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R-5114
Rev. 1/86

STATE OF MICHIGAN

JAMES J. BLANCHARD, Governor

DEPARTMENT OF NATURAL RESOURCES

STEVENS T. MASON BUILDING
BOX 30028
LANSING, MI 48909

RONALD O. SKOOG, Director

March 21, 1986

Ms. Edith M. Ardiente, Chief
Technical Programs Section
U.S. EPA - Region V
230 S. Dearborn
Chicago, Illinois 60604

Re: Ford Allen Park Clay Mine
MID980548711

Dear Ms. Ardiente:

As requested by your office, enclosed are the review comments for the proposed closure of Cell #1 at the above referenced facility.

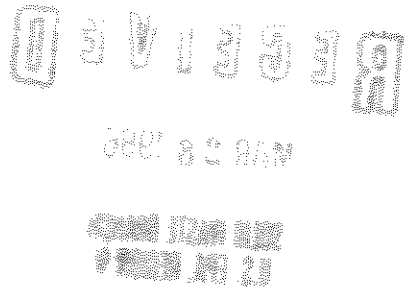
If you have any questions, please contact me.

Sincerely,

Pete Quackenbush, Engineer
Hazardous Waste Division
517-373-2730

Enclosure

COPY 2



Ford Allen Park Clay Mine
Review Comments

Closure of Cell #1

1. The shallow rooted vegetative cover for the cover system must be provided. (265.310(a)(2)).

2. The basis of design for selection of 20 mil FML in the cover system based on anticipated stresses from installation and settlement must be provided. (265.410)

3. The plan proposes to place either Class II or Class II aggregate and/or drainage piping directly onto the cover FMC. Clay is to then be compacted above the aggregate. Demonstration of how the 20 mil FML will be protected from the probable puncturing from above by the Class II or III material or the drainage piping must be provided. (265.111)

4. The plan must describe in detail construction procedures for such activities as the clay dike extensions, keying of cover clay into the clay dikes, achieving the appropriate density for cohesive and granular materials, the placement of materials onto the FML, plus a detailed quality assurance program for all construction activities. (265.111)

5. Sheet 3 of the engineering plans shows a portion of the cover along the eastern dike to have a 50% slope and the northern dike to have a 25% slope. This steep of a slope will cause unacceptable erosion problems which will require a re-design of that area. (265.301(b)(3))

6. The cover FML must extend at least to the hazardous waste boundary and be securely anchored at that location. (265.111)

7. The cover/liner between cells #1 and #2 must meet the requirements for both liners and covers. This will necessitate that the design of cell #2 be included as part of cell #1 closure plans. (265.310)

8. The plan does not address the run-off control measures (ditches, etc.) to be utilized based on this design. This must be provided. (265.310(a)(3))

9. It is not clear exactly what the intent and/or conclusions of stability work done by NT&H are. Further, what are the implications of the calculation values reached with respect to the present design? Specifically, leachate pipe spacing calculations are provided for various collection sand permeabilities, but no value is given as a specification for the permeability of the sand, so that the appropriate pipe spacing can be designed. Additionally, settlement calculations are provided for Station 68+00E (NT&H, June, 1984)

which is in cell #2 and an area which appears to be somewhere between cells #1 and #2, but is labeled "Generalized cell #2 (NT&H, December 1985)." Calculations for the latter also reference calculations dated 1/17/85 which are not provided. Clarification as to the exact locations of these analysis and a discussion of what the results mean must be provided. Calculations are provided for the stability of the cell #2 foundation (Cell #1 waste and/or fill) but the results of these analyses are not consolidated into a clear discussion and design package based on results. Documentation of the basis of assumptions must be provided and/or incorporated into the design specifications. (265.111)

10. The material, manufacturer and specifications of the FML to be utilized for both the cover of cell #1 and for the interface liner/cover must be provided as well as the results of waste/liner compatibility testing. (265.310(a)(1))

Ford Allen Park Part B File

STATE OF MICHIGAN

JAMES J. BLANCHARD, Governor

DEPARTMENT OF NATURAL RESOURCES

STEVENS T. MASON BUILDING
BOX 30028
LANSING, MI 48909

RONALD O. SKOOG, Director

March 21, 1986

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Technical Programs Section
U.S. EPA - Region V
230 S. Dearborn
Chicago, Illinois 60604

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Sincerely,

Pete Quackenbush

Pete Quackenbush, Engineer
Hazardous Waste Division
517-373-2730

Enclosure

COPY 1

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YELLOW

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
230 SOUTH DEARBORN ST.
CHICAGO, ILLINOIS 60604

REPLY TO THE ATTENTION OF:
5HS-13

23 JAN 1986

Mr. Alan J. Howard, Chief
Technical Services Section
Hazardous Waste Division
Michigan Department of Natural Resources
P.O. Box 30028
Lansing, Michigan 48909

RE: Closure Plan
Ford-Allen Park Clay Mine
Allen Park Michigan
MID 980 568 711 Cell # I

Dear Mr. Howard:

Enclosed is/are Under separate cover, you have received a copy ~~(s)~~ of a closure plan for the referenced facility. Please perform a technical evaluation of the plan, and provide us your comments by February 28, 1986.

If you have any questions on the closure plan, please contact Rich Traub of my staff, at (312) 886-6138.

Sincerely,

Edith M. Ardiente

Edith M. Ardiente, P.E.
Chief, Technical Programs Section

Enclosure(s)

cc: Mary Higgins
HWDMS Update File

	TYP.	AUTH.	IL. CHIEF	IN. CHIEF	MI. CHIEF	MN/WI CHIEF	OH. CHIEF	TPS CHIEF	WMB CHIEF	WMD DIR
INIT.	Y.W.	RJT			JK					
DATE	1/22/86	1/23/86			1-23-86					

SFL-5

ROUGE STEEL COMPANY

3001 Miller Road
P. O. Box 1699
Dearborn, Michigan 48121-1699

January 9, 1986

RCRA Activities
US EPA Region 5
P.O. Box 3587
Chicago, Illinois
60690-3587

Attention: SHS-13

SUBJECT: Ford Allen Park Clay Mine
Partial Closure Plan - Cell I
MID 980568711

Enclosed for your review is a copy of the subject closure plan dated January 10, 1986, accompanied by the associated engineering drawings dated January 6, 1986. Your expeditious review and approval of the plan would be appreciated in order to effect closure as scheduled for 1986.

Please contact David Miller at (313) 322-0700 with any questions you have regarding the subject closure plan.

Very truly yours

Douglas A. Painter
Manager
Mining Department

cc: A. Howard MDNR
L. AuBuchon MDNR

sh

228-45

Ford Motor Company

3001 Miller Road
Dearborn, Michigan 48121

October 30, 1985

RCRA Activities
U.S.E.P.A. Region V
P. O. Box 3587
Chicago, Illinois 60690-3587

ATTENTION: 5HS-13

SUBJECT: Ford Allen Park Clay Mine
Minimum Technological Requirements
MID 980568711

As per the meeting of October 9, 1985 and the subsequent telephone conversation of October 24, 1985 between Mr. David Miller of this office and Messrs. Traub and Hamper of EPA Region V, the proposed resolution of issues relating to the closure of Hazardous Waste Cell I is as follows:

1. Install a leachate collection system in the south corner of Cell I, as indicated in the Engineering Drawings dated August 1, 1985.

2. Fill non-hazardous waste over the leachate collection system to provide the appropriate slopes to support the proposed liner/cover as indicated in the August 1, 1985 Engineering Drawings. This concept is consistent with the May 24, 1985 EPA Guidance Document on the Implementation of Minimum Technological Requirements.

3. Ford will submit a partial closure plan for hazardous waste disposal Cell I. We will attempt to complete this by the end of the year.

Construction of Cell II will follow the minimum technological guidance document dated May 24, 1985 and meet the RCRA performance design standard established per Section 3004(o)(5)(B) by employing a liner design variance utilizing an upper synthetic liner (80 mil) and a lower clay liner. The lower clay liner will consist of recompacted clay in areas that require fill in order to reach design grades and in-situ clay for the remainder of the cell.

228-42

The in-situ clay will meet the performance standard as demonstrated in the previously submitted groundwater waiver demonstration. The engineering design for this liner construction will be submitted to your office for review in early 1986. Construction will then commence in good faith compliance under provisions of RCRA Interim Status.

Yours very truly,

Ben C. Trethewey, Manager
Mining Properties Department

DSM:lr

cc Del Rector, Chief
Hazardous Waste Division
Michigan Department of Natural Resources
P O Box 30028
Lansing, Michigan 48909

February 29, 1984

Mr. Ben C. Trethewey, Manager
Mining Properties Department
Ford Motor Company
3001 Miller Road - Room 2042
Dearborn, Michigan 48121

MID980568711

Dear Mr. Trethewey:

As part of our FY84 Hazardous Waste Management Cooperative Agreement with the U.S. EPA, we are obligated to review the adequacy of the closure and post-closure plans for all major hazardous waste treatment, storage and disposal facilities (TSDFs) in the state. All TSDFs which are licensed under 1979 PA 64, as amended, and those which are subject to the RCRA Part 264/265, Subpart F groundwater monitoring requirements, are defined as a major facility. EPA and the Department have also identified additional "major" facilities on the basis of the type and quantity of waste treated, generated or disposed of.

Your facility is considered a "major" facility. Therefore, please submit two up-to-date copies of your closure and post-closure plans for your land disposal facility by March 21, 1984.

The plans should be sent to the following address:

Hazardous Waste Division
Michigan Department of Natural Resources
P.O. Box 30038
Lansing, Michigan 48909

If you have questions regarding this letter, please contact Mr. Alan Howard, Chief of our Technical Services Section, at (517) 373-2730.

Sincerely,

Delbert Rector, Chief
Hazardous Waste Division
(517) 373-2730

pQuackenbush/vls
cc: U.S. EPA
District/Ken Burda

PARTIAL CLOSURE PLAN

Cell I

Ford Allen Park Clay Mine

MID 980568711

January 10, 1986

TABLE OF CONTENTS

I. FACILITY CONDITIONS

A. General Information: The overall landfill site is composed of approximately 183 acres of solid waste landfill, 17 acres of hazardous waste landfill, 33 acres of greenbelt and approximately 27 acres have been utilized for easements.

The hazardous waste disposal cells were constructed during the clay mining operation, which created a pair of 8 acre excavations (Cell I & Cell II) that are 35 feet deep. Hazardous waste landfilling activity has been restricted to the east corner of Cell I. The following waste volumes have been disposed of to date.

7,193 cubic yards of K061
6,788 cubic yards of K087
16,136 cubic yards of Blast Furnace Filter Cake
3,612 cubic yards of Basic Oxygen Furnace Dust
66,000 cubic yards of soil (daily cover)
99,729 cubic yards

The entire site is underlain by an insitu uniform clay deposit. An artesian aquifer is located 40 feet below the cell bottoms with a hydrostatic head of 80 feet. These conditions will prevent migration of leachate out of the liner during the active life of the operation.

B. Partial Closure: The minimum technological requirements of the 1984 Hazardous and Solid Waste Amendments necessitate the premature closure of Cell I and the redesign of Cell II. The closure of Cell I involves the following activities as indicated on the Engineering Drawings dated January 6, 1986.

1) Installation of a leachate collection system in the south corner of Cell I.

2) Redistribution of waste from the east corner to achieve final grades.

3) Landfill an estimated 49,000 cubic yards of non-hazardous waste in the south corner to provide the appropriate slopes to support the liner for Cell II.

4) Application of final cover to Cell I.

II. FINAL COVER FOR CELL I

A. Purpose. The purposes for the final cover are (1) to provide long-term minimization of percolation from precipitation into the waste, (2), to function with a minimum of maintenance, (3) to promote drainage while minimizing erosion, (4) to maintain integrity in the event of limited settlement of the waste surface, and (5) to provide foundation support for a portion of the synthetic liner to be installed in Cell II.

B. Design Elements. The final cover system must consist of the following elements:

1. A bedding layer, installed per section VI A of this plan, above the surface of the waste consisting of a minimum of 12 inches of silt, clayey silt, or silty clay with a classification of ML, CL-ML, or CL as determined by ASTM Method D2487-69;

2. A 20 mil thick synthetic flexible membrane liner (FML) installed per section VI B of this plan and as shown in the Engineering Drawings dated January 6, 1986

3. A granular FML protection/drainage blanket layer as specified in section VI C of this plan;

4. A compacted soil layer, placed directly over the drainage blanket layer, consisting of a minimum of 3 feet of compacted clayey soil having a classification per ASTM D2487-69 of CL or CH, and installed per section VI D of this plan;

5. A layer of topsoil placed directly over the compacted clay layer, consisting of a minimum of 4 inches of sandy loam as described in

section VI E of this plan;

6. A vegetative crop to be established per section VI F of this plan.

C. Final Contours

The final contours of the constructed final cover must result in slopes between 3% and 5% and must conform to the topography for Cell I as shown on the Engineering Drawings dated January 6, 1986. Deviations from the elevations are permitted to the extent they are necessitated by complying with the thickness requirements stipulated for the clay liner and topsoil in sections VI D and VI E of this plan.

D. Gas Wells

The waste materials as listed on page 1 do not generate gases. Therefore gas venting wells will not be installed.

III. SCHEDULE OF ACTIVITIES FOR PARTIAL CLOSURE (Cell I)

Feb. 1, 1986	-	Prepare Leachate Collection System
March 31, 1986	-	On-Site disposal completed
April 30, 1986	-	Facility decontaminated.
May 15, 1986	-	Finish grade and proof roll liner bedding
July 15, 1986	-	Complete installation of 20 mil FML and installation of FML protection/drainage layer.
August 15, 1986	-	Complete construction of clay cap.
Sept. 1, 1986	-	Complete final grading of topsoil.
Oct. 1, 1986	-	Fertilize, seed, and mulch to establish final cover crop.

Total time required - 198 days.

If it is not possible to complete the partial closure within this schedule Ford Allen Park Clay Mine must submit a written request to the Regional Administrator for a longer partial closure period pursuant to 40CFR 265.113(b)

IV. MAXIMUM WASTE INVENTORY

Not applicable. An inventory of waste is not maintained at the site.

V. DECONTAMINATION OF EQUIPMENT

Equipment which comes in contact with hazardous waste will be scraped clean with a shovel as the decontamination procedure.

VI. CONSTRUCTION SPECIFICATIONS FOR FINAL COVER OF CELL I

A. Construction of bedding layer.

1. The layer upon which the flexible membrane liner (FML) is to be placed consists of a minimum of 12 inches of silt clayey silt or silty clay with an ASTM Method D 2487-69 classification of ML, CL-ML, or CL.
2. The upper 4 inches of the layer must not contain particles larger than 1 inch in diameter.
3. The surface of the layer must be rolled with a smooth steel drum or pneumatic roller so as to be free of irregularities, loose earth, and abrupt changes in grade.
4. No FML may be placed in ponded precipitation or in any area which has become softened by precipitation to unconfined compressive strength less than 0.5 tons per square foot (50 kPa).
5. The FML installer (see VI B.1.1) must provide written certification as to the acceptability of the surface preparation of the layer prior to each day's installation of FML.
6. Ford must make provisions for material, personnel, and equipment necessary to maintain an acceptable surface of the bedding layer for FML installation.
7. Ford must obtain direct layer thickness measurements at a rate of at least once per every half-acre to verify conformance with design requirements.

B. Installation of Flexible Membrane Liner

The flexible membrane liner (FML) must be installed directly over the bedding layer described in section VI A of this plan by an organization (installer) which is responsible for: the receipt, inspection, and handling of FML materials and equipment: the unrolling, placing, seaming, testing and repairing of the FML during installation: and other aspects as assigned in this section (VI B).

1.1 FML Installer

The installer must be trained and qualified to install the type of FML to be used for the project. To demonstrate the necessary training and qualifications the installer must provide Ford and the independent registered professional engineer required by 40 CFR 265.115 (IRPE) with a summary of at least previous installations, totaling a minimum of 250,000 square meters, containing the following information:

Name and purpose of project, location, date, name of owner, designer manufacturer, leader of the installer's crew, type of FML, thickness, surface area, type of seaming, duration of installation, and available written information on the performance of the project.

2.1 Raw Materials

The FML must be manufactured of first quality newly produced raw materials. The use of reclaimed polymers and other materials is not permitted. Recycling of materials containing reinforcing scrim is not permitted. Recycling scrap that does not contain scrim is permitted.

The FML Manufacturer must provide Ford and the IRPE (i) an indication of the origin of raw materials; (ii) a copy of any quality control certificates issued by the producer of raw materials; and (iii) reports on any tests conducted to verify the quality of the raw materials.

2.2 Rolls

a. The FML must be designed and manufactured specifically for the purpose of fluid containment. The FML must be free of holes, blisters, undispersed raw materials, and any sign of contamination by foreign matter.

b. **The FML must be a minimum of 20 mils thick.**

c. The following information shall be provided by the FML Manufacturer as an indication of the quality of the material supplied:

Material properties sheet, pertaining to the FML to be used for the project, containing results of protocols for tensile properties and project, tear resistance as specified in the NSF Standard 54 specifications. The sheet must also provide any minimum properties guaranteed by the FML Manufacturer and indicate test methods used.

Quality control certificates pertaining to the **rolls** of material delivered to the site must accompany the rolls. Each roll shall be identified by a unique manufacturing number. The quality control certificates shall be signed by a responsible party employed by the FML Manufacturer, such as production manager, and shall be certified.

2.3 Factory Seaming

a. If the FML rolls are fabricated into designed blanket sizes before delivery to the site, one of the following seaming techniques must be used: adhesive, heat seaming, or dielectric seaming.

b. The overlap must provide the minimum required seam width (as indicated on the next page). The seam must extend to the edge of the sheet, so that no loose flap is present on the top side of the blanket. A loose flap is

permissible on the bottom side of the fabricated blanket.

c. The rolls must be laid out without tension and seamed without wrinkles or fishmouths. If wrinkles occur within the sheet due to the seaming process, the wrinkle must not extend into the seamed width. Wrinkles which extend into the seamed width must be treated as specified in Section VI B 3.5.7.

d. The overlap area to be seamed must be free from moisture, dust, dirt, debris of any kind, and foreign material. The fabrication area must be in a clean, enclosed, temperature controlled facility.

e. Any dielectric and heat seaming devices must be accurately monitored and controlled at all times to effect a consistently acceptable seamed width. Dielectric bars or wheels with ribs must effect the full specified seam width. Space between the bar ribs must not be counted in the seam width.

f. Any adhesive used for seaming the rolls together must not be deleterious to the FML material in any way after seaming. The adhesive product must be applied as specified by the FML manufacturer with special attention to the ambient temperature and rolling pressure. The adhesive must have been tested for longevity in contact with the FML material and its application must not result in appreciable stiffening of the FML. Prepared adhesive tapes must not be used.

g. The minimum seam widths shall be:

	Unreinforced	reinforced
Adhesive seaming	25 mm (1 in.)	50 mm (2 in.)
Heat seaming	25 mm (1 in.)	25 mm (1 in.)
Dielectric seaming	20 mm (3/4 in.)	25 mm (1 in.)

3.1 Packaging of FML

FML rolls or blankets must be packed and labeled prior to shipment to the site. The label must indicate the FML Manufacturer, type of FML, thickness, and roll or blanket number.

3.2 Transportation of FML

When transported to the site, FML rolls or blankets must be handled by appropriate means so that no damage is caused. Wooden cases must be strong enough to withstand impacts and rough handling without breaking or splintering.

3.3.1 On-site Storage of FML

The FML must be protected from direct sunlight and heat to prevent degradation of the FML material and adhesion of individual whorls of a roll or layers of a blanket.

Adequate measures must be taken to keep FML materials away from possible deteriorating sources (i.e., vandalism, theft).

3.3.2 On-site Handling of FML

Appropriate handling equipment must be used when moving rolled or folded FML from one place to another.

3.3.3 Panel Placement of FML

a. Each roll or blanket must be redesignated with a panel number. A panel is the unit area of in-place membrane which is to be seamed (i.e., one roll may be cut into several panels). Instructions on the boxes or wrapping containing the FML materials must be followed to assure the panels are unrolled or unfolded in the proper direction

for seaming. Only the panels which are to be anchored or seamed together in one day shall be unrolled or unfolded. Care must be exercised to not damage the FML during this operation. All workers must wear shoes which will not damage the FML .

b. Pulling FML panels must be minimized to reduce permanent tension.

c. The following precautions must be taken to minimize the risk of damage by wind during panel placement:

No more than one panel should be unrolled prior to seaming (unless authorized by the installer);

Work shall be oriented according to the direction of prevailing winds if possible.

Adequate loading on FML panels to prevent uplift by wind must be provided by sand bags, tires or any other means which will not damage the FML. Along the edges, loading must be continuous, to avoid possible wind flow under the panels.

d. Any panels which become seriously damaged (torn or twisted permanently) must be replaced. Less serious damage must be repaired according to Section 4.4.

e. FML placement must not proceed at an ambient temperature below 5 ° C (41°F) or above 35°C(95°F), unless otherwise specified.

f. FML placement must not be done during precipitation events.

3.4 Considerations of Site Geometry

3.4.1 Layout Drawings

The FML Installer must provide to Ford and the IRPE layout drawings of the proposed FML placement pattern and seams prior to FML placement. The drawings must indicate the panel configuration and location of seams. Field seams should be differentiated from factory seams (if any). In general, seams should be oriented parallel to line of the maximum slope. In corners and odd shaped geometric locations, the total length of field seams should be minimized. No seams should be placed at the toe but should be a minimum of 1.5m (5 ft) away from the toe of the slope.

3.4.2. Installation Around Appurtenances

a. The FML must be installed around the leachate collection manhole and a FML sleeve or shield must initially be installed around the concrete riser prior to the areal FML installation. After the FML has been placed and seamed, the final field seam connection between the appurtenance sleeve or shield and the FML must be completed. A sufficient initial overlap of the appurtenance sleeve must be maintained so that shifts in location of the FML can be accomodated. The installation of the leachate discharge pipe through the FML will be as shown on the Engineering Drawings dated January 6, 1986.

b. All clamps, clips, bolts, nuts or other fasteners used to secure the FML around each appurtenance must have a life-span equal to or exceeding the FML.

3.5 Field Seaming

3.5.1 Requirements of Personnel

a. All personnel performing seaming operations must be qualified by experience or by successfully passing seaming tests.

b. At least one seamer must have experience seaming at least one hundred thousand m^2(1.07 million sq. ft.) of a FML of the same generic type as the FML used for the project using the same type of seaming method. This master seamer must provide direct supervision over apprentice seamers.

c. Apprentice seamers must be qualified by attending training sessions taught by the master seamer and performing at least two successful seaming tests under similar weather conditions using the seaming method used for production seaming.

3.5.2. Overlapping

The panels shall be overlapped a minimum of 100 mm(4 in.) if heat seaming is used, or a minimum of 150 mm(6 in.) if adhesive seaming is used.

3.5.3 Preparation

Prior to seaming, the seam area must be clean and free of moisture, dust, dirt, debris of any kind, and foreign material.

3.5.4 Seaming Equipment and Products

Any heat seaming device (hot air or hot wedge) must include a thermometer allowing the temperature to be monitored. Any adhesive (bodied solvent compound or cement) used shall be formulated in accordance with the FML Manufacturer's specifications.

3.5.5 Weather Conditions for Seaming

Weather conditions required for seaming are as follows: (i) no weld shall be done below $1^{o}C(34^{o}F)$; (ii) between $1^{o}C(34^{o}F)$ and $10^{o}C(50^{o}F)$, seaming is possible if the FML is preheated by either sun or hot air device, and if there is not excessive cooling resulting from wind; and (iii) above $10^{o}C(50^{o}F)$, no preheating is required. In all cases, the FML must dry.

3.5.6 a. Seaming on horizontal surfaces must commence at the center of a panel side and proceed to either end of a side (if possible) in an effort to reduce wrinkles and subsequent fishmouths at the seam interface. The direction of seaming on slopes shall be the most expedient direction for the type of seaming used. Seaming shall extend to the outside edge of panels.

b. If the supporting soil is soft, a firm substrate must be provided by using a homogeneous board or similar hard surface directly under the seam overlap to effect proper rolling pressure.

c. If reinforced PVC and heat seaming is used, the width of the seam shall be 25mm (1 in.) scrim to scrim. Then, the loose upper flap must be bonded using either a hot air gun or an adhesive (bodied solvent or cement). If unreinforced PVC and adhesive seaming is used, the width of the seam must be 100 mm (4 in.) starting from the edge of the FML placed on top (so there is no loose flap). If unreinforced PVC and heat seaming is used, the width of the seam must be 25 mm (1 in.) starting, if possible, from the edge of the FML placed on top. Any loose flap must be bonded using either a hot air gun or an adhesive.

3.5.7 Procedure for Seaming Wrinkles

a. Fishmouths or wrinkles at the seam overlaps must be cut along the ridge of the wrinkle back into the panel so as to effect a flat overlap. The cut fishmouths or wrinkles must be seamed as well as possible, and then patched with an oval or round patch of the same generic FML extending a minimum of 150 mm (6 in.) beyound the cut in all directions.

b. The patch must be bonded over its entire area, using either a hot air gun or an adhesive (bodied solvent or cement).

3.5.8 Cap-strips

a. Cap-strips must be placed on all defective seams which are not reparable by reseaming, in accordance with Section VI B 4.4.3. They may be placed only after quality control of the original seam has been performed.

b. Cap-strips must be at least 75 mm (3 in.) wide and must be centered over the completed seam edge. Cap-strips must be of the same generic FML material as the liner but without reinforcing scrim. The thickness of cap-strip must be at least 20 mils.

4.1 Quality Control and Inspection

a. The test reports, material properties sheets, and quality control certificates required in Sections VI B 2.1 and 2.2 must be supplied to Ford and the IRPE by the FML Manufacturer prior to fabrication (or installation if there is no fabrication).

b. The quality control certificates must be reviewed to verify that a certificate has been received for all rolls.

4.2 Transporation, Handling and Placement

a. Upon arrival of the FML at the site, the Installer must inspect all materials for defects in the manufacturing process and for damage during transportation. Materials judged to be severely damaged must be rejected and removed from the site. Minor damages and other defects shall be repaired.

b. The Installer must inspect each panel, after placement and prior to seaming, for damage caused by placement operations or by wind. Damaged panels or portions of damaged panels which have been rejected, must be marked and their removal from the work area recorded.

c.. The Installer must also verify that the weather conditions (air temperature, non-excessive wind, and lack of precipitation) are acceptable for panel placement, in accordance with Section VI B 3.5.5.

4.3 Field Seams

4.3.1 Field Seaming Operations

The Installer must verify that:

The seaming personnel have the qualifications required in Section VI B 3.5.1.

The overlaps meet the requirements presented in Section VI B 3.5.2.

The seaming area is clean, as described in Section VI B 3.5.3.

A hard substrate such as a board is used if the supporting soil is soft.

Seaming equipment and adhesive products are available on the site and meet the requirements presented in Section VI B 3.5.4.

Weather conditions for seaming are acceptable, as required in Section VI B 3.5.5.

Seaming procedures described in Section VI B 3.5.6 are followed.

The panels are properly positioned to minimize wrinkling and wrinkled areas are seamed according to the procedures presented in Section VI B 3.5.7.

All cap-strips required in Section VI B 3.5.8 are placed.

Equipment for testing seams is available on site.

4.3.2 Test Seams

a. Test seams must be performed to verify that seaming conditions are adequate. Test seams shall be conducted at the Installer'a discretion and at least two times each day (at the beginning of the morning and the beginning of the afternoon), for each seaming equipment or adhesive product used that day. Also, each seamer must perform at least one test seam each day. Test seaming must be performed under the same conditions as production seaming. The test seam must be at least 0.6m (2 ft) long.

b. Specimens must be cut from the test seam. These specimens must be 50 mm (2 in.) wide. Specimens shall be tested by hand in shear and peel, and shall not fail in the joint. If a test seam fails, an additional test seam shall be immediately conducted. If the additional test seam fails, the seaming equipment or product must be rejected and not used for production seaming until the deficiencies are corrected and a successful full test seam is produced.

c. A sample from each test seam must be retained and labeled with the date, ambient temperature, number of seaming unit, seamer, and pass or fail description. One half of the sample must be given to the FML Installer for subsequent laboratory testing and the other half retained by Ford.

4.3.3 Non-Destructive Seam Testing

a. All field seams must be non-destructively tested over their length. Each seam must be numbered or otherwise designated. The location, date, test unit, name of tester, and outcome of all non-destructive testing must be recorded by the Installer.

b. Testing must be done as the seaming progresses, not at the completion of all field seaming. All defects found during testing must be numbered and marked immediately after detection. All defects found must be repaired, retested and remarked to indicate completion of the repair and acceptability.

c. The test unit shall be air lance or vacuum test unit.

4.3.4. Verification of Seams in Special Locations

a. All seams in special locations must be non-destructively tested if the seam is accessible to testing equipment. If the seam cannot be tested in-place, but is accessible to testing equipment prior to final installation, the seam must be non-destructively tested prior to final installation (e.g., seams around pipes and gas wells). If the seam cannot be tested in-place, not prior to final installation, it must be observed by FML Installer, for uniformity and completeness.

b. The seam number, date of observation, name of tester, and outcome of the test or observation must be recorded.

c. All defective seams must be promptly repaired, retested and remarked to indicate completion of the repair.

4.4 Defects and Repairs

4.4.1 Identification

a. All seams and non-seam areas of the FML must be inspected for identification of defects, holes, blisters, undispersed raw materials and any sign of contamination by foreign matter.

b. The surface of the FML shall be clean at the time of inspection. Sweeping and/or washing of the FML surface is required if the amount of surface dust or mud inhibits inspection.

4.4.2 Evaluation

Each suspect location both in seam and non-seam areas must be non-destructively tested using the methods described in Section VI B 4.3.3. Each location which fails the non-destructive testing must be marked and repaired.

4.4.3 Repair Procedures

Defective seams must be repaired by reseaming or applying a cap-strip. Tears or pinholes must be repaired by seaming or patching. Blisters, larger holes, undispersed raw materials, and contamination by foreign matter shall be repaired by patches. Each patch must be numbered. Patches must be round or oval in shape, made of the same generic FML and extend a minimum of 150 mm (6 in.) beyond the edge of defects.

4.4.4 Verification of Repairs

Each repair must be non-destructively tested using the methods described in Section VI B 4.3.3. Tests which pass the non-destructive tests are taken as an indication of an adequate repair. Failed tests must be reseamed

and retested until a passing test results. All non-destructive testing of repairs and the number of each patch, date, location, patcher and test outcome must be recorded.

4.5 Documentation

4.5.1 Material Quality Control Certificates

The quality control certificates pertaining to raw materials and manufactured FML rolls required in Sections VI B 2.1 and VI B 2.2 must be provided by the FML Manufacturer to Ford prior to installation. The test results shall be reviewed for completeness and for compliance with the required minimum properties for both the raw materials and manufactured FML rolls. Materials and rolls which are in non-compliance with the minimum required properties must be rejected.

4.5.2 Daily Field Installation Reports

a. The FML Installer must provide Ford with daily reports of: (i) the total amount and location of FML placed; (ii) total amount and location of seams completed and seamer and units used; (iii) changes in layout drawings; (iv) results of test seams; (v) location and results of non-destructive testing; (vi) location and results of repairs and; (vii) location of destructive test samples.

b. Ford must record daily all activities of the FML installation, which shall include but not be limited to:

receipt of the written daily acceptance of surface preparation from the FML Installer;

Observations of test seams, including seaming unit number of identification of adhesive products, names of seamers, weather conditions and results;

observations of field seaming operations, including weather conditions, cleaning, overlaps, rate of seaming, names of seamers and units used; observations of seams around appurtenances, and connection to appurtenances;

observations of non-destructive seam testing, including testing location of defects and testing unit used;

observations of repairs and retesting, including locations, name of repairer and seaming equipment or product used.

C. Contruction of the FML protection/drainage blanket layer

1. The granular material comprising this layer must be classified as SW, SP, SP-SM, or SM (provided that no more than 15%, by weight, is made up of particles smaller than 75 microns), according to ASTM Method D2487-69, based on at least one sample per every 5000 cubic yards.

2. The title and pipe must consist of 4 inch diameter SD 21 HDPE perforated pipe, placed as shown on the design plans. Perforations shall be 0.25 inches in diameter or width and will provide at least 0.25 square inches of open area per foot of pipe length.

3. The pipe must be wrapped with geotextile filter material possessing an equivalent opening size no greater than the opening size of a #70 standard sieve.

4. The granular material comprising the layer must be placed on the FML in a manner that does not damage it or the drainage pipe system.

5. Initial granular material placement must be done by placing the material at the toe of the lined slope and pushing the material up the side slope with appropriate equipment.

6. The full design thickness of the granular material layer must be maintained when spreading the material and for any construction traffic on the layer.

7. Ford must obtain direct layer thickness measurements at a rate of at least once per every half-acre to verify conformance with design requirements.

D. Construction of Clay Layer

1. A compacted, fine-grained, cohesive soil layer must be placed over the FML protection and drainage blanket layer described in Section VI C of this plan.

2. The soil must meet the CH or CL classification as determined by ASTM Method D2487-69. The classification must be confirmed by samples obtained at least once per every 25,000 cubic yards of borrow material.

3. At least one sample per every 25,000 cubic yards of clay material must be subjected to ASTM Method D1557-78 and item 4 of this section in order to obtain (a) optimum moisture content: (b) maximum dry density: and (c) the relationship between saturated hydraulic conductivity, and 90% of maximum dry density at optimum moisture content, optimum plus 8 percent, and optimum minus 2 percent.

4. Values for saturated hydraulic conductivity must be obtained using one of the following methods: (a) Appendix 1; (b) the direct measurement technique using a consolidometer with a vertical lead of 0.5 ton per square foot, according to paragraph 8 of Appendix VII in Laboratory Soils Testing, EM-1110-2-1906, U.S. Department of the Army, 1970. Samples shall be prepared using the procedures in section 2.7.3 of U.S. EPA Draft RCRA Guidance Document, Landfill Design Liner Systems and Final Cover, 1982, (except ASTM Method D1557-78 shall be used in lieu of D698-70.) The test shall be repeated until results indicate saturated conditions have been obtained. (c) a compaction permeameter method using apparatus described in section 2.7.2 of the referenced draft RCRA Guidance Document, except where the Harvard Miniature Compaction Apparatus replaces the ASTM standard mold and 2 kg. hammer. Samples shall be prepared according to section 2.7.3 of the draft document, except where the compaction technique shall be associated with the Harvard Miniature Compaction Apparatus in lieu of ASTM D 698-70. The test procedure shall be according to section 2.7.4 of the draft document, except that, alternatively, falling head procedures may be used.

5. The soil must be placed in lifts with maximum loose thickness of eight inches.

6. No frozen soil may be used in any lift, nor may any soil be placed on a frozen base.

7. The soil must not be placed in a manner that would trap ponded water.

8. The soil must be compacted with sheepsfoot rollers or large diameter rubber tire equipment. The clay layer must be compacted to achieve particle configuration resulting in (a) density values equal to or greater than 90 per cent of maximum dry density and (b) moisture content values between 2 per cent below and 8 per cent above optimum moisture content.

9. During compaction of the clay layer the moisture content of the soil must be kept between 2 per cent below and 8 per cent above the optimum moisture content determined, as necessary, by ASTM Method D3017-78.

10. Material, personnel, and equipment such as discs, harrow or plow, and sprinkling system must be available to moisten or dry material as required to meet the moisture content specification of paragraph 9.

11. Values for density in field compacted soils must be determined by ASTM Method D 2922-81 at least once per every 1000 cubic yards of compacted soil to verify the density specification of paragraph 8 (a).

12. Values for moisture content in field compacted soils must be determined by ASTM Method D 3017-78 at least once per every 1000 cubic yards of compacted soil to verify the moisture content specification of paragraph 8 (b).

E. Topsoil specifications

1. A layer of topsoil at least 4 inches thick after grading must be placed over the clay lay described in section VI D of this plan.

2. The topsoil must be a sandy loam confirmed by grain size analyses conducted according to ASTM Method D422-63 at least once per every 3000 cubic yards to be placed.

3. The top 1/2 inch of the topsoil layer must be loosely packed to provide an acceptable seed bed.

4. Ford must obtain direct measurements of topsoil thickness at the rate of at least once per every half-acre to verify conformance with E.1.

F. Vegetative cover specifications.

1. The topsoil described in VI E must be fertilized with 12-12-12 N-P-K at the rate of 650 pounds per acre.

2. The following seed mix must be sown into the topsoil:;

Seed	per cent by Weight
a. common cereal rye	20 to 30
b. common creeping red fescue	20 to 30
c. common Kentucky bluegrass	5 to 10
d. Kentucky 31 tall fescue	100 - (a + b + c)

3. The seed mix must have a germination rate of at least 80%.

4. The seed mix must be applied at the rate of 200-225 pounds per acre.

5. The seed bed must be rolled during or immediately after seed application.

6. Straw mulch must be applied to the seed bed at the even rate of 1.5 to 2 tons per acre in a manner that will minimize subsequent displacement by wind.

7. Thirty to forty-five days after seeding, the cover crop must be fertilized with a follow-up application of 650 pounds per acre of 12-12-12, or equivalent actual N-P-K application.

Appendix 1

Triaxial-Cell Method With Back Pressure for Determining Hydraulic Conductivity

1. Scope and Application

This method is applicable for all soil types, but especially for fine-grained, compacted, cohesive soils in which full fluid saturation of the sample is difficult to achieve. Normally, the test is run under constant-head conditions.

2. Apparatus

The apparatus is similar to conventional triaxial apparatus. The schematic diagram of this apparatus is shown in Figure 3.

3. Procedures

3.1 Sample preparation. Samples are compacted to appropriate densities using methods described in ASTM D698-70.

3.2 Test procedures

3.2.1 Measure the dimensions and weight of the prepared sample

3.2.2 Place one of the prepared specimen on the base.

3.2.3 Place a rubber membrane in a membrane stretcher, turn both ends of the membrane over the ends of the stretcher, and apply a vacuum to the stretcher. Carefully lower the stretcher and membrane over the specimen as shown in Figure 3. Place the specimen cap on the top of the specimen and release the vacuum on the membrane stretcher. Turn the ends of the membrane down around the base and up around the specimen cap and fasten the ends with O-rings.

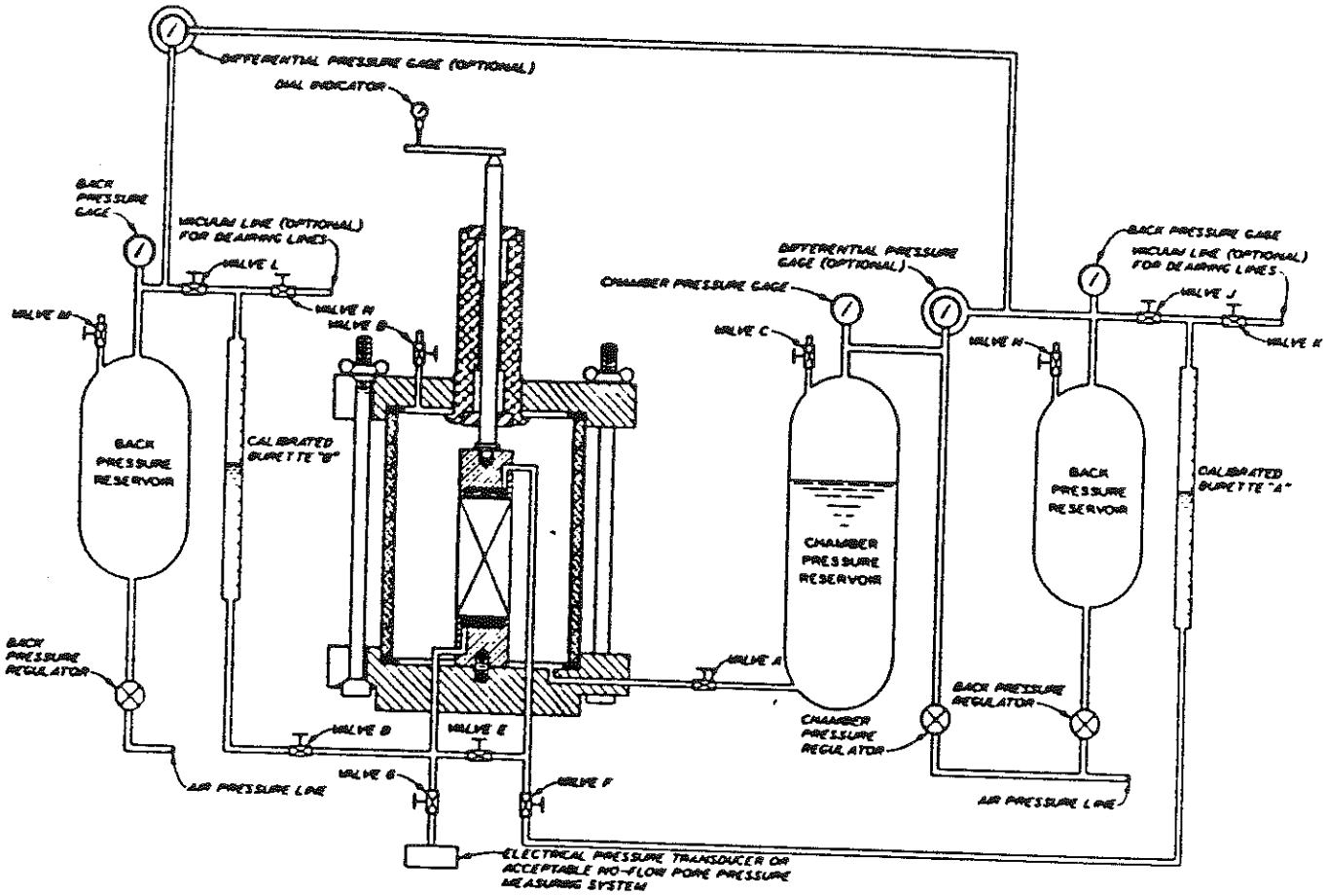

Figure 3. Schematic diagram of typical triaxial compression apparatus for permeability tests with back pressure

3.2.4 Assemble the triaxial chamber and place it in position in the loading device. Connect the tube from the pressure reservoir to the base of the triaxial chamber. With valve C (see Figure 3) on the pressure reservoir closed and valves A and B open, increase the pressure inside the reservoir, and allow the pressure fluid to fill the triaxial chamber. Allow a few drops of the pressure fluid to escape through the vent valve (valve B) to insure complete filling of the chamber with fluid. Close valve A and the vent valve.

3.2.5 Place saturated filter paper disks having the same diameter as that of the specimen between the specimen and the base and cap; these disks will also facilitate removal of the specimen after the test. The drainage lines and the porous inserts should be completely saturated with de-aired water. The drainage lines should be as short as possible and made of thick-walled, small-bore tubing to insure minimum elastic changes in volume due to changes in pressure. Valves in the drainage lines (valves E, F, and G in Figure 3) should preferably be of a type which will cause no discernable change of internal volume when operated. While mounting the specimen in the compression chamber, care should be exercised to avoid entrapping any air beneath the membrane or between the specimen and base and cap.

3.2.6 Specimens should be completely saturated before any appreciable consolidation is permitted, for ease and uniformity of saturation, as well as to allow volume changes during consolidation to be measured with the burette; therefore, the difference between the chamber pressure and the back pressure should not exceed 5 psi during the saturation phase, the back pressure must be applied in small increments, with adequate time between increments to permit equalization of pore water pressure throughout the specimen.

3.2.7 With all valves closed, adjust the pressure regulators to a chamber pressure of about 7 psi and a back pressure of about 2 psi. Now open valve A to apply the preset pressure to the chamber fluid and simultaneously open valve F to apply the back pressure through the specimen cap. Immediately open valve G and read and record the pore pressure at the specimen base. When the measured pore pressure becomes essentially constant, close valves F and G and record the burette reading.

3.2.8 Using the technique described in step (3), increase the chamber pressure and the back pressure in increments, maintaining the back pressure at about 5 psi less than the chamber pressure. The size of each increment might be 5, 10, or even 20 psi, depending on the compressibility of the soil specimen and the magnitude of the desired consolidation pressure. Open valve G and measure the pore pressure at the base immediately upon application of each increment of back pressure and observe the pore pressure until it becomes essentially constant. The time required for stabilization of the pore pressure may range from a few minutes to several hours depending on the permeability of the soil. Continue adding increments of chamber pressure and back pressure until, under any increment, the pore pressure reading equals the applied back pressure immediately upon opening valve G.

3.2.9 Verify the completeness of saturation by closing valve F and increasing the chamber pressure by about 5 psi. The specimen shall not be considered completely saturated unless the increase in pore pressure immediately equals the increase in chamber pressure.

3.2.10 When the specimen is completely saturated, increase the chamber pressure with the drainage valves closed to attain the desired effective consolidation pressure (chamber pressure minus back pressure). At zero elapsed time, open valves E and F.

3.2.11 Record time, dial indicator reading, and burette reading at elapsed times of 0, 15, and 30 sec, 1, 2, 4, 8, and 15 min, and 1, 2, 4, and 8 hr, etc. Plot the dial indicator readings and burette readings on an arithmetic scale versus elapsed time on a log scale. When the consolidation curves indicate that primary consolidation is complete, close valves E and F.

3.2.12 Apply a pressure to burette B greater than that in burette A. The difference between the pressures in burettes B and A is equal to the head loss (h); h divided by the height of the specimen after consolidation (L) is the hydraulic gradient. The difference between the two pressures should be kept as small as practicable, consistent with the requirement that the rate of flow be large enough to make accurate measurements of the quantity of flow within a reasonable period of time. Because the difference in the two pressures may be very small in comparison to the pressures at the ends of the specimen, and because the head loss must be maintained constant throughout the test, the difference between the pressures within the burettes must be measured accurately; a differential pressure gage is very useful for this purpose. The difference between the elevations of the water within the burettes should also be considered (1 in. of water = 0.036 psi of pressure).

3.2.13 Open valves D and F. Record the burette readings at any zero elapsed time. Make readings of burettes A and B and of temperature at various elapsed times (the interval between successive readings depends upon the permeability of the soil and the dimensions of the specimen). Plot arithmetically the change in readings of both

burettes versus time. Continue making readings until the two curves become parallel and straight over a sufficient length of time to determine accurately the rate of flow as indicated by the slope of the curves.

3.3 Calculations The hydraulic conductivity can be calculated using the following equation:

$$K = QL/hA$$

where

K = hydraulic conductivity, LT^{-1}.

L = length of sample, L.

A = cross-sectional area of sample, L^2.

Q = outflow rate, L^3T^{-1}

h = fluid head difference across the sample, L.

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JOB Allen Park Clay Mine PROJECT NO. 84185 SHEET NO. 1/9
SUBJECT Final Cover BY KIG DATE 5/23/84
CHK. BY WRH DATE 6/15/84

FINAL COVER EVALUATION COPIED BY LJS 6-27-84

SOIL EROSION

The Universal Soil Loss Equation as presented in U.S.E.P.A. SW-867, 1982;

$$A = RKLSCP$$

where:

A = average annual soil loss in tons/acre

R = rainfall/runoff erodibility factor

use R = 110 (from fig. 20 USEPA SW-867, 1982)

K = soil erodibility factor in tons/acre

use K = 0.25 silty clay cover w/little or no organic content

LS = slope length and steepness factor

maximum length north-south ≈ 1200 ft

maximum overall grade = 4% so

LS = 1.1 (Table 6, USEPA SW-867, 1982)

C = cover management factor

continuous grassy cover (meadow maximum)

use C = 0.025 (Table 7, USEPA SW-867, 1982)

P = conservation practices to reduce erosion

use P = 1.0 conservative assumption; no support practices (Table 8, USEPA SW-867, 1982)

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$A = 110(0.25 \text{ tons/acre})(1.1)(0.025)(1.0)$

$A = 0.76$ tons/acre

Erosion loss is less than 1.0 ton per acre per year.

FUNCTION OF DRAINAGE BLANKET

- to transmit water percolating through the compacted clayey soil layer off the cell.

I. Total Percolation through silty clay layer

Assume saturation of clay with no ponding or backup within the drainage blanket

use: $q = K_c I$

where:

K_c = compacted permeability of silty clay cover layer

I = hydraulic gradient

use: $K_c = 5.8 \times 10^{-8}$ cm/sec - permeability of 2 remolded gray silty clay samples from site compacted 90% or more.

see: Hydrogeological Report - Allen Park Clay Mine MTE, 11/24/81

$I = 1.0$ because clay is assumed saturated without ponding on top of cap.

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$$q = K_c I = 5.8 \times 10^{-8} \frac{cm}{sec} (1.0) \left(\frac{in}{2.54 cm}\right)\left(\frac{3600\ sec}{hr}\right)$$

$$= 8.2 \times 10^{-5}\ in/hr$$

maximum percolation for 1200' strip (1 ft wide) through the clay ⇒

$$8.2 \times 10^{-5}\ in/hr \left(\frac{14.965\ gpd/ft^2}{in/hr}\right) = 1.23 \times 10^{-3}\ gpd/ft^2$$

so $1.23 \times 10^{-3}\ gpd/ft^2\ (1200\ ft) = 1.47\ gpd/ft$ of width

II. Flow through sand Blanket Drain

sand in blanket drain is Class II

according to: MDOT (1984)

Class II Fine Aggregate is primarily a fine sand with a maximum of 7% silt or clay-sized material

use $K = 1.0 \times 10^{-2}$ cm/sec (Matrecon, 1980)

Assume minimum slope is 3%
with slope length = 1200 ft

If layer is flowing full with no excess head at base of clay:

$$Q = K I A$$

use unit area, i.e. 1 ft thick, 1 ft wide

so:

$$Q = 1 \times 10^{-2} \frac{cm}{sec} \left(\frac{2.12 \times 10^4\ gpd/ft^2}{1\ cm/sec}\right)(0.03\ ft/ft)(1\ ft)$$

$Q = 6.4$ gpd/ft of width

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so Drainage Blanket Capacity (6.4 gpd/ft) exceeds estimated inflow (1.5 gpd/ft) along a 1ft wide strip by ≈ 4 times.

III Edge Drain Capacity

Edge drain is 4" ϕ @ 0.1% slope (min)

for maximum flow capacity - use Hazen Williams eqn.

$$V = 1.318\, C_{hw}\, R_h^{0.63}\, S^{0.54}$$

& $Q = VA$ continuity eqn.

where:

Q = flow, ft^3/sec

V = velocity, ft/sec

C_{hw} = roughness coefficient

use $C_{hw} = 80$ (conservative)

R_h = hydraulic radius = pipe dia./4 (if flowing full)

$R_h = 4"/4 = 0.083\ ft$

S = slope of pipe

assume $\geq 0.001 = 0.1\%$ slope

A = area, ft^2

$= (0.333\ ft)^2 \cdot \frac{\pi}{4} = 0.087\ ft^2$

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$$V = 1.318\,(80)\,(0.083)^{0.63}\,(0.001)^{0.54}$$

$$= 1.318\,(80)\,(0.21)\,(0.024)$$

$$= 0.53 \text{ ft/sec}$$

$$Q = (0.53 \text{ ft/sec})(0.087 \text{ ft}^2)$$

$$= 0.046 \text{ ft}^3/\text{sec} = 29700 \text{ gal/day}$$

Maximum infiltration through clay cover = 1.23×10^{-3} gpd/ft^2

Proposed hazardous waste cover area

$= 670 \text{ ft} \times 1200 \text{ ft} = 804{,}000 \text{ ft}^2$

$Q_{infiltrate} = 1.23 \times 10^{-3} \text{ gpd/ft}^2 \times 804{,}000 \text{ ft}^2 = \underline{989 \text{ gpd}}$

Therefore drain capacity exceeds expected flow by over one order of magnitude. A single drain will be sufficient. However, additional drain pipes and 3 outlets are included for redundancy.

IV Filter Requirements between pipe and Class II sand.

Use geotextile filter. See design of leachate collection system.

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V Open Area on Perforated Pipe

Assume maximum inflow to perimeter drain is 1.47 gpd/ft (with S.F. = 2 — use 3.0 gpd/ft)

Limit Entrance Velocity to 0.1 ft/sec (U.S. Army TM 5-818-5, 1971)

$$\frac{3.0 \text{ gpd/ft}}{0.1 \text{ ft/sec}} = 4.6 \times 10^{-5} \text{ ft}^2/\text{ft}$$

OR $0.007 \text{ in}^2/\text{ft}$

Required open area on perforated pipe is $0.007 \text{ in}^2/\text{ft}$ to handle maximum infiltration. Actual open area will be at least $0.25 \text{ in}^2/\text{ft}$. Will use 1/4" ϕ holes.

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CHK. BY LJS DATE 6/27/84

Settlement

Primary consolidation of the waste will occur very rapidly. Sowers (1973) indicates this will be within 1 month of loading. Construction of the final cover can be expected to be completed within 9 months of receipt of last wastes (40 CFR 264.113). The cell will be filled slowly over an extensive period. For analysis, we will assume that all primary consolidation and the first 5 years of secondary compression will be complete prior to cover construction.

Assume the moderately compacted industrial wastes will possess a void ratio of approximately 2.0

$\alpha_{secondary} \approx .09\, e_o = .09(2) = 0.18 \rightarrow$ use 0.2 (Sowers, 1973)

This is for conditions unfavorable to decomposition because no general refuse is in this cell.

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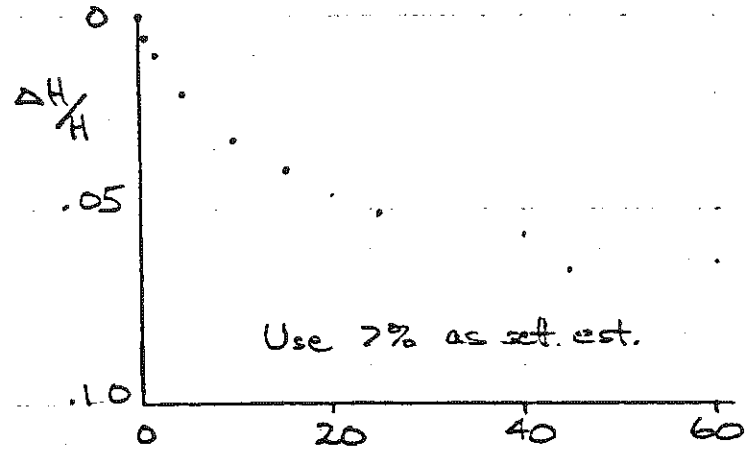
CHK. BY LJS DATE 6/27/84

$$\frac{\Delta H}{H} = \frac{\alpha \log (t_2/t_1)}{1+e} \qquad t_1 \approx 5 \text{ yrs}$$

t_2	$\Delta H/H$
6	.005
7	.010
10	.020
15	.032
20	.040
30	.052
50	.067



Estimate of post-cover settlement → $\Delta H/H \approx 7\%$

Post-cover settlement estimates:

Max. fill depth occurs near 6800 E

Surface grade = 634 Base grade = 564

(634-564) - 5 ft (cover) = 65 feet of fill

65 x .07 = 4.55 ft → Max est. sett. = 5 ft.

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SUBJECT Final Cover Evaluation BY MJS DATE 6-27-84
CHK. BY GJRP DATE 6/28/84

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